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ABSTRACT

The materials and methods described in this report constitute an integrated system which allows a professional educator with a minimum of data processing experience to teach a course in computer technology. The course is divided into three teaching modules--(1) general background and programing, (2) techniques and applications, and (3) advanced applications to individual disciplines. For each instructional unit in a teaching module a unit description is given, the unit's content is outlined, and supplemental material is suggested. Appendices to each module provide a variety of reference lists and source guides to allow the program user to keep abreast of the current technical innovations. A data processing course which used these materials is described and evaluated. (JY)

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FINAL REPORT
Project No. 0-0026
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INSTRUCTIONAL MATERIALS FOR TRAINING IN COMPUTER USAGE

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Wilkes-Barre, Pa. 18701

August 1970

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I. SUMMARY

Objectives

This project, entitled "Development of Instructional Materials for Training in Computer Usage," was initiated by InTech Corporation to produce the comprehensive materials necessary for teaching computer information technology. The high quality instructional materials which were successfully developed as a direct result of the project will significantly contribute to meeting the nation's critical needs for expanding knowledge of electronic data processing. More specifically, the project was designed to:

1. Establish a documented, integrated technical-educational system, through the combined efforts of a professional research team, including educators and guidance personnel, for development of a total data processing educational program with a chain reaction.

2. Provide a methodology by which the educator can incorporate current technological advances into the system, assuring accurate and relevant instructional material.

3. Enable educators to utilize this knowledge within their immediate disciplines, conduct in-service and elementary-secondary level training programs, and apply computer information technology as a potent administrative device.

Background

Since the installation of the first commercial computer in 1951, the computer revolution has had a dramatic impact on our scientific, commercial, political, and economic environment.

"By the end of 1969 the total value of installed EDP equipment will reach $35 billion. That's a gain of 400% in five years - and over 1300% in ten years . . . and it's reliably predicted that by the end of the next decade a computer--or at least a computer terminal--will be in use at most firms in this country with twenty employees or more."[1] However, the phenomenal growth of the industry, and technological breakthroughs have created a "people gap" that leaves the problem-solving capabilities of computers largely untapped.

The computer revolution is considered by many to be still in its infancy. Dr. John Mauchly, co-inventor of the computer, has stated that "Costs have come down a million-fold in the past twenty years and we haven't seen any leveling off. The cheaper we make computers, the more useful they will be." As costs continue to decline, computers will become commonplace and someday will be found in almost every factory, office, classroom, airplane, library, and business establishment.

Those now engaged in education, commerce, industry, the trades, and the professions find themselves increasingly affected by the computer, yet find themselves poorly equipped to understand or utilize it for their own ends. The "need to know" of those now coming of age is even greater. The population expansion has been accompanied by an information explosion, and the youth of today must be considerably more informed than those of past generations, or the results of research and new technology will go unused.

1 Boyd, W. Walter, Computerworld Newsletter, June, 1969.

The teacher is the necessary link to expand the electronic age, but unfortunately most teachers in our school systems today have not even been exposed to this technology. The Pennsylvania Department of Public Instruction has estimated that only a few hundred of the state's 80,000 teachers have a working knowledge of data processing. Although this illustrates the predicament in only one state, the problem is nationwide, as evidenced by the fact that many of the data processing courses offered across the country have been taught by part-time personnel active in the industry, rather than by trained educators.

The availability of data processing courses is extremely limited for educators. Those courses which are available are frequently inaccessible either due to time schedule or location, and are usually not comprehensive and/or not directed toward educators. Additionally the routine technological strides common within the industry far outstrip educational program development. Constant technical advances account for various obstacles in data processing training. The most important of these is the lack of available quality computer technology programs, texts, and teaching aids. Courses that do exist are often outdated as shown by their emphasis upon factors such as mathematics, unit record equipment, first or second generation concepts, and neglect of the current "state of the art." The technical information explosion renders conventional texts obsolete within a few short years, sometimes upon publication. Up-to-date teaching aids for data processing courses are extremely limited.

"State of the art" information can be found only in the voluminous technical literature, such as vendor manuals, magazines, research findings, and newsletters, which are distributed within the industry. This means that the educators who are trained in data processing are significantly handicapped in their efforts to present timely and relevant computer courses. "Since relatively few good textbooks are available in the computer sciences, the computer science faculty will need to devote an unusually large part of its time to searching literature and developing instructional materials."[2]

This project was conceived as a means of producing innovative teaching materials to overcome the obstacles confronting professional educators in developing data processing programs for general education. By use of these materials a professional educator with a minimum of data processing experience is able to teach an effective computer technology course. The teaching materials were developed as an integrated system, and yet were designed so that they can easily be tailored to various types of data processing courses. In addition, the project emphasized the provision of a method for keeping the developed materials current as to the "state of the art".

The materials and methods as described in this report present an effective tool to be used in the presentation of data processing technology to a variety of audiences; their effectiveness has been demonstrated at the secondary and baccalaureate levels with individuals of varying backgrounds and interests.

[2] Communications of ACM, March, 1968

Teaching Materials

The teaching modules are divided into three distinct phases. Phase I of the instructional materials provides a basic foundation upon which Phase II and Phase III can build. Beginning with a brief history of the evolution of computer technology, the materials progress to presentations concerning the underlying principles of hardware, software, and processing techniques. Prior to the development of programming skills, the students gain experience with data processing decision making techniques. The final units of this phase are designed to provide a working knowledge of the two most universal programming languages, COBOL (COmmon Business Oriented Language) and FORTRAN (Formula Translator).

Phase II deals with the overall approach to the use of computer technology as a problem solving tool. All of the conceptual material and practical experience gained in the first phase is applied to systems and procedures to form a solid foundation for problem solutions through the application of computer technology. The materials in this phase include lecture topics, case studies and problems which graphically integrate all data processing concepts and techniques as applied to applications of general interest in government, industry, and education.

The third and final phase applies computer technology to the field of education and the participant's individual discipline. Computerized instructional systems, selecting a computer, and teaching materials unique to data processing are covered in this phase. The students participate in a research effort to present the most current material available regarding Applications in Education. The last instructional

unit consists of guidelines specifying the method by which students will apply the knowledge they have gained to an individual project.

The modular organization and structure of these instructional materials enhances the feasibility of its application to various types of data processing courses. All topics may be covered if the course is directed toward educators. In addition, selected units may be used as introductory or short courses. Computerized Instructional Systems could be used for an in-service training program. Selection of a Computer lends itself to a specialized presentation for administration and/or business management. The first phase could stand alone as a secondary level course. In this case, both languages or one language with the Systems and Procedures unit could be taught. Each programming unit could, in fact, be presented as a concentrated programming course.

Each instructional unit consists of the following:

1. Unit Description
    a. Title
    b. Suggested presentation time
    c. General narrative of content
    d. Delineation of major subject divisions
    e. Objectives
2. Detailed Content Outline
3. Supplemental
    a. Suggested class reference material
    b. Annotated bibliography
    c. Teaching aids
        1) Annotations of existing materials
        2) Suggested illustrations for presentations

3) Suggested materials for classroom distribution with appropriate sources

d. Laboratory problems and solutions

e. Suggested activities

Each module is designed so that it can be easily updated. The appendices provide a variety of reference lists and update sources for those utilizing the materials. In this manner, the program user can keep abreast of the most current technical innovations. The appendices include enumerations of:

1. Texts - an annotated bibliography which enables the user to easily select those texts suited to his specific needs.

2. Audio-visual materials - a list of source addresses providing assistance in acquiring recommended commercially available materials.

3. Reference materials - includes various organizations which disseminate computer technology information as well as periodicals useful as reference sources and current guidebooks.

4. Educational, technical, and management societies - a short description of the organization's purpose and a list of its publications.

5. Technical journals and magazines - a list of periodicals which provide pertinent technical information for data processing instructors.

6. Educational journals - this list includes periodicals devoted to the dissemination of the latest trends in education and instructional methods; some concentrate exclusively upon the application of computer technology to education.

These will serve as a valuable source of information for the continual updating of the materials' entirety. Assuming the normal diligence of a professional teaching staff, the obsolescence factor previously associated with data processing materials will be surmounted.

Methodology

The system of organizing materials and the material content were tested in conjunction with narrative scripts. The first test of the developed materials was made when they were used to teach a group of 60 educator/participants to apply computer technology to their individual disciplines. These participants had virtually no previous experience and included administrators, guidance counselors and teachers from diverse subject areas.

The second test involved use of the instructional materials by several project participants in teaching computer technology courses to their students or other teachers. This was known as the control group.

The project extended from September 2, 1969, through August 31, 1970. The first six weeks were devoted to preparation of the teaching materials for the initial instructional units, and the selection of project participants. Classes were held from October 13, 1969, to June 26, 1970. During this time, Level 1 of the teaching materials was completed and presented to the participants. Research/system analysts attended the classes to ensure the technical accuracy and measure the level of effectiveness of the material presented. The results of their evaluation were incorporated into the materials. These revised materials (Level 2) were then distributed to the control group. The last stage of the project, that of final reporting, was completed in August, 1970.

II. MAJOR ACTIVITIES AND ACCOMPLISHMENTS

Instructional Units

The project's research and systems team was primarily responsible for the development of the instructional materials. The subject matter was organized into three major phases each of which was subdivided into instructional units. These units are listed below.

Phase I - General Background and Programming

Evolution of Data Processing
Data Representation
Data Management
Concepts of Data Processing Hardware
Concepts of Data Processing Software
Computer Processing Techniques
Decision Making Techniques
COBOL Programming
FORTRAN Programming

Phase II - Techniques and Applications

Data Processing Systems and Procedure Concepts
Integration of Systems and Programming
Practical Applications in Industry
Practical Applications in School Administration
Advanced Class Problem
Information Retrieval

Phase III - Advanced Applications to Individual Disciplines

Concepts of Computerized Instructional Systems
Selection of a Computer
Data Processing Teaching Aids
Current Applications in Education
Individual Problem

Material Development

Whenever possible, the elements of several units were developed simultaneously by various members of the team. Each unit started with the preparation of the unit description.

The content of this element, which includes an overview of the unit and its objectives, was based upon the Data Processing Curriculum for Educators (project reference number 8-0449, U.S.O.E.) and the findings of the Educators Information Technology System (Project EDITS, reference number 9-0184, U.S.O.E.). Special care was taken to ensure each objective was stated in terms of the level of achievement which could be realistically attained.

A major part of the development of the materials for each unit was research of all available technical literature. As work on each new unit began, one or more of the analysts identified all technical books and publications containing pertinent information. The annotated bibliography was begun during this period.

Once the unit description and primary research was completed for an instructional unit, development of the detailed outline began. The analyst who conducted the research was usually responsible for writing the initial outline. This was done in order to prevent loss of information in transmitting the results of the research.

The detailed outlines were written for an audience having no previous exposure to data processing. Unnecessary technical points were avoided. However, all points and subjects were included which would contribute to a thorough understanding of the unit. Great care was also given to achieving the best possible sequence of topics.

As the detailed outline was developed the accompanying laboratory problems and their corresponding solutions were developed. This enabled the instructor to frequently test the students' comprehension of the subject area.

Upon completion these materials were distributed to several analysts who critically read both elements. Appropriate changes were discussed and then incorporated into the materials.

During the entire period of instructional development, there was continued investigation of audio/visual teaching aids. All pertinent aids were ordered, reviewed and evaluated. If judged useful either as a general introduction or detailed discussion of a topic, the aid was included in the annotated list of commercially available teaching materials.

When a detailed outline was completed, a list was made of all the illustrations which could be used to enhance the presentation of the unit. Some were made into foils. Also prepared was a list of materials for distribution to the students for their enrichment or reference. Finally, reading assignments from selected textbooks were recommended.

Material Content

Phase I of the curriculum provides a basic foundation in data processing upon which the remaining material can build. Beginning with a brief history of data processing and the impact of the computer, this phase advances to basic elements and underlying principles of technology: hardware, software, and processing techniques, which in effect describe a computer and the basic theories of computer utilization. The final units of the phase are designed to provide a working knowledge of the two most universal programming languages, COBOL (COmmon Business Oriented Language) and FORTRAN (Formula TranslAtor).

Phase II of the project deals with the overall approach to utilizing computer technology as a problem solving tool. The information given in Phase I is here applied to the systems and procedures area to form a solid base in problem solution through the use of data processing equipment and techniques. This phase includes lecture topics, and case studies which illustrate applications of general interest in government, industry, and school administration. It is designed to show the feasibility of the use of computers in familiar situations.

The background and programming material of Phase I and the problem-solving techniques of Phase II are linked in Phase III which deals with the use of data processing in the field of education. The phase covers Computer Assisted Instruction (CAI) and Computer Managed Instruction (CMI) along with gaming, simulation, and other applications which demonstrate some of the uses of the computer as an educational tool. The final unit in the phase consists of guidelines specifying the method by which those who have mastered the body of the curriculum can develop and document a data processing system on an individual basis.

The content covered by each instructional unit includes the most recent developments and trends in the data processing industry. Obsolete subjects, such as unit record and first generation computer concepts are included only in the study of historical development.

Of the twenty instructional units, fourteen are composed of lecture material and five are primarily case studies (Integration of Systems and Programming, Practical Applications in Industry, Practical Applications in School Administration, Advanced Class Problem, and Individual Problem). One (Current Applications in Education) is designed to be presented as a discussion.

Instructional Unit Elements

For each instructional unit, material was developed which consists of the following interrelated elements.

1. Unit Description

The unit description gives an an overview of the unit's content. In addition, the objectives of the unit are detailed. Each unit description includes the following subdivisions:

a. Title of unit.
b. Suggested time required to cover the lecture material and the laboratory problems.
c. Overview of the content.
d. Delineation of the major subject subdivisions of the unit.
e. Objectives. The stated goals describe the level of ability and knowledge which the student should achieve upon completion of the unit.

2. Detailed Content Outline

The subject matter of each unit is detailed in the form of an outline which not only lists each subject to be covered but also enumerates pertinent points in

connection with that subject. The subjects are carefully organized so that each topic will build upon those preceding and will in turn serve as a foundation for the subjects which follow.

3. Supplemental

Each unit has a complementary supplemental section containing suggested materials and information which the instructor may find helpful in teaching the particular unit. Included are:

a. Suggested class reference material - Text assignments and additional student reference sources.
b. Annotated bibliography - Lists numerous sources of information on the topics covered by each instructional unit. The lists include information found in magazines, journals, conference reports and vendor publications, as well as in numerous technical books.
c. Teaching aids
   1) Commercially available audio-visuals. Includes movies, overhead transparencies, slides, taped lectures, etc. Each entry on the list is annotated and the source is given.
   2) Illustrations. The suggested illustrations can be made into transparencies to enhance the presentation of topics.
   3) Materials for class distribution. Miscellaneous material such as punched cards, hardware illustrations, etc.

d. Laboratory problems and solutions. Nearly half of the instructional units, consisting primarily of lecture material, have accompanying laboratory problems. For instance, in Phase I problems exist for both Data Representation and Decision Making Techniques, as well as for COBOL and FORTRAN Programming. Detailed problem definitions and appropriate solutions were included among the instructional materials whenever it was judged that laboratory work would contribute to the learning process.

e. Activities - In units where it was judged that either a field trip or a guest lecturer would be helpful, the suggested activity is described.

The laboratory problems and supplemental materials are coordinated with the detailed outlines by symbolic notations at the point of presentation where they can be most effective.

Utilization of the Materials

Course Initiation

A data processing course was conducted by InTech as a means of evaluating the developed instructional materials.

A set-up period from September 2, 1969, through October 10, 1969, involved the recruiting, selection, and orientation of participants.

Recruiting of Participants

Recruiting participants for the project was initiated at the monthly meetings of the Tri-County Principals Association of Luzerne, Carbon, and Columbia Counties and of the Guidance Counselors Association of lower Luzerne County. Information sessions regarding the course were also held at nine schools in the area, including junior and senior high schools, vocational-technical schools, and elementary schools.

The superintendents, supervisors, principals, and head teachers from lower Luzerne, Carbon, and Columbia Counties were sent a synopsis of the course, tentative enrollment sheets, and self-addressed envelopes. In addition, a summary of the course and its objectives was included for posting in each school. Application forms were then sent to all educators expressing interest in participating in the project.

Prior to the first class, 75 applications were received. After an orientation meeting, there were 20 immediate withdrawals, mainly because of previous time commitments and lack of guaranteed academic credits. Classes began with 55 participants; a short time later five additional educators were accepted for participation in the course.

Participants' Statistics

The 60 project participants were from 17 different schools and represented six school districts. The educational background of the participants is shown below:

Bachelor of Science	21
Bachelor of Arts	10
Master of Science	9
Master of Arts	9
Master of Education	11
	60

Of the 60 participants, eight were administrators, one was a librarian, and five were guidance personnel. The educators engaged in teaching taught diverse subjects such as mathematics, industrial arts, bookkeeping, chemistry, commercial law, health, music, speech therapy, etc. The teaching experience of the participants varied from one to 39 years. Most participants were in their first ten years of teaching. Two of the administrators had never taught.

None of the participants had prior experience with computer technology. Six had some exposure through courses previously taken; one was beginning his first term teaching computer programming.

Course Schedule

The course schedule conformed as closely as possible to the normal school year. Classes extended from October 13, 1969, through June 26, 1970, with provision for the usual school holidays. Two sections, with approximately 30 participants in each class, were scheduled for 3 1/2 hour evening sessions twice a week, (Monday-Wednesday and Tuesday-Thursday) for a total of seven hours per week. In addition, a course in FORTRAN was given on five consecutive Fridays.

Classroom Facilities

Initial arrangements were made with the Hazleton Board of Education for classroom facilities at Hazleton High School. During mid-November the classes were transferred to the Hazleton Area Vocational Technical School, which houses a computer. The classroom was located near the computer center and equipped with work tables.

Computer Utilization

The two instructional units which cover COBOL and FORTRAN programming demanded extensive laboratory exercises. Nearly 50% of the time spent on these units was utilized in flowcharting, coding, compiling, and debugging the various problems.

During the COBOL unit, "hands-on" testing and debugging of problems was conducted at a local service bureau equipped with an IBM 360/25 computer. For the FORTRAN unit "hands-on" experience was provided on the IBM 1130 computer located in the school.

Laboratory Sessions

Laboratory application was extensive throughout the course. As previously mentioned, five of the instructional units are primarily case studies and nearly half of the lecture instructional units have accompanying student problems.

In addition to programming, three of the case study units were particularly significant. The first, Integration of Systems and Programming, followed the theoretical study of systems analysis and design. Course participants were presented with the study of a problem of general interest, a voter registration system, designed to illustrate the interaction of systems and programming.

In the Advanced Class Problem, the participants worked in small groups to design a general system and various sub-systems for grade reporting. Each participant was required to provide his own documentation of the system.

The course closed with a final problem designed to illustrate the level of knowledge gained during the course. This required each participant to select a project related to his discipline which could be alleviated by data processing. The participants documented their problem and its solution, and included a narrative specifying the expected end product, their method of approach, a summary of the project, and a general statement of the proposed use of the end product.

Guest Lecturers

Periodically, guest lecturers addressed the participants. They presented the relationship of data processing to business, industry, education, and government. For example, Mr. Edward McLaughlin, business manager for the Wyoming Valley Sanitary Authority, addressed the participants on the subject of computer systems and the systems analyst. He defined the systems concept and enumerated the personal characteristics required of a systems analyst.

A second lecturer was Dr. Harold Mitzel, Assistant Dean of Research, College of Education, Pennsylvania State University. His lecture dealt with the effectiveness of new technology in education with particular attention toward computer assisted instruction (CAI). The talk was scheduled to coincide with the unit Concepts of Computerized Instruction.

A movie, lecture, and live demonstration of CAI were presented by two representatives of the Instructional Services Division of RCA.

Mr. Richard G. Bridle, Bache & Co. Account Executive, explained and demonstrated the use of the firm's information retrieval system in obtaining data on securities transactions.

Elizabeth Jahr, a teacher of data processing at Wilkes College, explained and demonstrated the time-sharing system used at the college, which allows their students to utilize the computer for problem solving.

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Field Trips

To effectively supplement the concentrated material offered throughout the course, several field trips were made by the participants. They toured an IBM 360 tape and disk computer system, an IBM 1130 disk system, and an IBM 1620 system. These tours served to illustrate not only the various pieces of hardware, but actual applications.

A trip was made to Wilkes College in Wilkes-Barre, Pa., to show the participants a time-sharing system in operation and the use of teletypewriters. Finally, the participants were taken on a tour of the Wilkes-Barre office of the Bache and Company brokerage firm.

Project Advisory Committee

Since the SCRIPT project encompasses three counties (Luzerne, Carbon, Columbia) it was not practical to attend all the superintendents' meetings. Therefore, an advisory committee was formed of prominent educators from each county and various levels of education. Members were:

Mr. Lawrence Evangelista	Principal, Hazleton High School
Mr. Angelo DeCesaris	Director, King's College Data Processing Center
Mr. Elmer Huggler	Principal, Jim Thorpe Area School District
Mr. Frank C. Kostos	Director, Hazleton Campus, Pennsylvania State University
Dr. Henry F. Paterson Jr.	Superintendent, Hazleton Area School District
Mr. Donald N. Rishe	Assistant Superintendent, Central Columbia School District
Dr. Ellis W. Roberts	Project Educational Consultant

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The committee met every second month to discuss the project and lend guidance and direction. In this manner the school districts were constantly apprised of the progress of the participants. The last meeting was held at King's College, and Mr. DeCesaris conducted a tour of the college's new computer facilities.

Evaluation and Revision of Materials

Classroom Evaluation

In addition to the instructor, two systems analysts were present during each class. They were responsible for evaluating the instructional materials in the actual classroom situation. They paid particular attention to the flow of the topics and to the clarity of the presentation of the more technical material. They closely observed the audience's reaction to the material and noted the questions. The supplementary teaching aids which were suggested for each instructional unit were evaluated for their effectiveness in contributing to the learning process. Each observer documented his findings.

The instructors were responsible for evaluating and documenting the topics covered, class participation, visual aids, and additional information on the effectiveness of the class presentation. One of the instructors, a member of the control group, had less than a year's exposure to EDP. He was especially helpful in evaluating the material as to its comprehensiveness and technical level. He was also useful in determining the amount of support needed for an inexperienced instructor.

Revision of Materials

Following the presentation of each instructional unit, it was reviewed and evaluated by the research analysts, the class observers, and the instructors. This group corrected the problems encountered during the class presentation. The research analysts were responsible for making the changes to the material. The updated material was then critically read by another staff analyst. His suggestions were discussed and incorporated into the material.

Control Group

The effectiveness of the revised instructional materials was further evaluated. Regular faculty members of area high schools and a vocational-technical school used them to instruct their high school and adult students. These courses were monitored and evaluated by the project staff. This helped to ensure that the final materials would provide ample instructional support even for an instructor with limited EDP knowledge.

The control group consisted of:

1. One course taught in Wilkes-Barre Township High School, Wilkes-Barre, Pa., to business students of the junior class. It involved weekly one-hour sessions. The instruction covered all of the units in Phase I except the programming unit.
2. Two courses were conducted as part of the regular curriculum of the Hazleton Area Vocational Technical School. Day classes for high school students were held three hours a day, five days a week. In addition, the materials were used for adult evening classes.

3. At Central Catholic High School, Kingston, Pa., seminars were given, using extracted material. Full-time day classes will begin in September using the instructional units of Phase I and II.

Appendices

The appendices were compiled as a result of research and evaluation of material throughout the project. They provide sources for reference and updating and include enumerations of:

1. Texts - an annotated bibliography which enables the user to easily select those texts suited to his specific needs.

2. Audio-visual materials - a list of source addresses providing assistance in acquiring recommended commercially available materials.

3. Reference materials - includes various organizations which disseminate computer technology information as well as periodicals useful as reference sources and current guidebooks.

4. Educational, technical and management societies - a short description of the organization's purpose and a list of its publications.

5. Technical journals and magazines - a list of periodicals which provide pertinent technical information for data processing instructors.

6. Educational journals - this list includes periodicals devoted to the dissemination of the latest trends in education and instructional methods; some concentrate exclusively upon the application of computer technology to education.

III. FINDINGS AND ANALYSIS

The EDP courses successfully demonstrated that the topics covered by the instructional materials provided an effective data processing course for professional educators with a minimum background in computer technology.

Course Conducted by InTech

Demonstrated Interest

The interest of educators was immediately apparent by the ease with which the participants were recruited. Upon the announcement of the implementation of the course, the enthusiastic response, from teachers and administrators alike, was overwhelming. The minimum absenteeism throughout the course was another indication of interest. Despite the long class hours and the total course length, the average attendance level was 81%.

Another gratifying fact was that only 18 of the original participants chose to withdraw from the course before its completion. Only four of these withdrew for reasons directly related to the course.

Participants' Mastery of the Material

The participants' mastery of the material presented in the course was significantly demonstrated by their success at the various laboratory problems. For example, all of the participants successfully coded, compiled, and debugged one program and all but a few completed additional programs. Later, in the Selection of a Computer unit, each individual was required to select and justify one of three competing vendor proposals. In order to arrive at a conclusion, extensive use of the knowledge previously gained in the course was

necessary. Their selections showed obvious understanding of computer selection principles. A significant measure of the effectiveness of the course is the final individual projects.

The effort put forth by the participants resulted in projects that were well-planned, practical solutions to realistic problems in various areas of education. Evaluation of the projects revealed a high degree of competence on the part of the educators, to whom the field of electronic data processing was quite foreign just a short time ago.

Participants' Evaluation of the Course

Following the completion of the course, letters were sent to the participants requesting their comments and suggestions.

Responses expressed appreciation for the opportunity to participate in the program. Their reaction to most aspects of the course was extremely favorable. In general, they were impressed with the presentation of comprehensive, well-organized material.

Curriculum Revision

The evaluation of the instructional materials in the classroom situation resulted in several revisions to the materials.

Redefinition of Instructional Units

Data Representation and Management was divided into two instructional units: Data Representation and Data Management. This was done to conform to the module organization of the instructional materials since they are two separate and complete topics.

The second unit subdivided was COBOL and FORTRAN Programming. The original aim of this unit was to teach both of these languages as a coordinated unit. Due to time limitations each language was taught as a separate unit. All of the students learned COBOL. Since FORTRAN is directed toward the solution of math-science problems it was given as an option; fifteen participants elected to attend five extra class sessions in order to learn it.

Adjustment to Suggested Time

As several of the instructional units were presented to the class, time schedules suggested for some of the units were adjusted. In general, more time was required for case study units than was anticipated. For example, the time suggested for the Advanced Class Problem and Individual Problem units was changed from 14 to 21 hours and 28 to 35 hours respectively.

Control Group

The control groups verified the usefulness of the instructional materials. The instructors felt that the materials gave them invaluable assistance. On an individual basis they would not have been able to research the details necessary for presentation of all the topics. Since they were able to depend entirely upon the instructional materials developed by InTech, they presented more informative courses. In addition, the materials were well defined and easy to present.

Although the instructors generally considered the use of the instructional materials in their course a complete success, they had a few recommendations. One was that additional laboratory work in the first five or six units of Phase I would aid the students in learning and retaining more of the information presented as lecture. The second principal recommendation

was that the materials be designed to include several lists of review questions which could be used throughout the course, in addition to the laboratory problems.

Unique Advantages of Materials

A feature of the materials which greatly contributed to maximum flexibility is their modular organization. The topics were broken into instructional units and a complete set of elements was developed for each unit, so that an instructor can use only those units which would contribute to his course. The units chosen would depend on both course length and major objectives.

A course for educators may include all of the units; various units may be skipped, such as Programming, or Practical Applications in Industry; or may consist of only one unit, such as Concepts of Computerized Instruction. If the audience is composed of school administrators, or business managers, a seminar using only the Selection of a Computer unit can be conducted.

Phase I could stand alone as a complete secondary level course. Both programming languages, or one language with the Systems and Procedures unit from Phase II, could be taught. The COBOL or FORTRAN units could, in fact, be presented as a concentrated programming course.

All case studies were organized as separate instructional units. In addition, the problems associated with a lecture unit form a separate element of the teaching materials. This allows the instructor to easily incorporate his own case studies or problems.

Updating Materials

Technical advances have been constant in the field of data processing. This results in almost immediate obsolescence of most of the data processing texts and related materials. The minimizing of this problem was a major aim during the planning and development of the instructional materials. The modular organization allows the instructor to easily incorporate new advances. An entirely new unit can easily be inserted.

InTech has organized the materials to facilitate updating, and sources of current data processing information have been provided as supplements to the instructional materials. By use of these source lists a data processing instructor can easily keep up with the "state of the art." Thus, the instructional materials are not only easy to update but are accompanied by material which will lead the instructor to current information. As a result, the instructor can overcome the usual problem of rapid obsolescence of data processing teaching material.

IV. CONCLUSIONS

This project has succeeded in developing comprehensive instructional materials which can provide complete support for instructors of computer information technology. Through critical evaluation of the project, InTech believes that the objectives stated in the proposal have been met.

An instructional unit, as originally proposed, constitutes a total system of comprehensive instructional materials. The elements, although separate, are integrated so that an instructor using the materials can easily draw upon each element in order to optimize his teaching process.

The topics covered by the materials include all basic aspects of data processing as used in the fields of industry or education. At least 266 hours are required to include all of the topics. The materials provide an understanding of data processing history, hardware and software concepts, processing techniques, specific programming languages, and systems concepts. In addition, they cover case studies such as applications in industry and education, information retrieval, and concepts of computerized instruction.

It has been demonstrated that the use of the instructional materials results in a high quality comprehensive course, appropriate for students with no data processing background. In addition, it was shown that the materials provide effective support for instructors of data processing courses.

We feel confident that the instructional materials developed will energize a chain reaction through their use in training educators, who in turn will be able to utilize them to conduct data processing courses for other educators and for their students.

The first stage in achieving the chain reaction effect has been accomplished as part of this project. That is, 60 educators have participated in the extensive data processing course conducted by InTech to demonstrate the effective use of the instructional materials. Their success at mastering the material, which was amply attested to during the course, offers assurance that they will be able to pass on their new knowledge.

The second stage has been effected by the control group. Several schools which were not able to offer computer technology courses, due to the lack of knowledgeable teachers, are now able to include it in their curriculums.

The chain reaction was reinforced by designing the instructional materials so that they can be utilized by an instructor with a limited background in data processing. The educators trained by InTech will be able to use the materials to achieve a multiplier effect resulting in the widespread dissemination of accurate data processing knowledge in general education.

They have gained knowledge usable within their immediate disciplines. In addition, they are able to disseminate their new knowledge in data processing training programs, or by applying it as an administrative tool.

The individual projects, which were related to the participants' disciplines, included such diverse applications as an inventory control system, a student scheduling application, a computer-assisted instruction system for basic mathematics, and an information retrieval system for zoological data. Each of the completed projects showed a high degree of competence, and many were rated as excellent. Several have been of immediate value to the respective schools and school districts of the participants.

The successful completion of the individual projects provides a significant indication of the serviceability of the developed instructional materials as a basis for computer information courses. The use of these materials not only results in an in-depth comprehensive data processing course, but also greatly eases the job of disseminating knowledge of this dynamic tool, the computer.